Dredging Research

Vol 4, No. 3 Information from the Engineer Research and Development Center Sept. 2001

Cape Fear, North Carolina, selected for nearshore mixed sediment mound project

by Jack E. Davis and Carl Miller, Coastal & Hydraulics Laboratory, ERDC, and Philip M. Payonk, Wilmington District

In the September 2000 issue of "Dredging Research" (Vol. 3, No. 3) we reported on DOER research into the fate and effects of nearshore mounds of mixed sediment, sediment that contains sand and a large fraction of finer sediment. In the article, we outlined the plans for the construction of a mound near the U.S. Army Engineer R&D Center's Field Research Facility (FRF) at Duck, NC. The North Carolina environmental community and Federal resource agencies were enthusiastic about a scientific field-monitoring study of a mixed-sediment mound that joined physical and biological research in a prototype project. Most saw that the information regarding the fate of nearshore sediments would benefit those having to make decisions regarding dredging material management and dredged material placement operations. And certainly, a better understanding of sediment processes and their effect in the ocean environment would improve the Corps dredging programs.

While the environmental agencies approved of the project planned for the FRF, accomplishing the plan required another level of effort and investigation. The Corps does not dredge in the area around Duck except for Oregon Inlet some 20 miles to the south. The only economically possible approach was to dredge sediment off the seabed near the FRF and place it at the mound location. Initially, it appeared that suitable sediment could be in the area. However, more intensive investigations of the seabed revealed that most of the surface sediment was fine sand without silts and clays. Hence, no mixed sediments were available for placement and study at the FRF.

While the facilities and capabilities of the FRF offered an unprecedented opportunity to intensively monitor a dredged-sediment mound, the lack of suitable sediment led to the selection of an alternative site.

New Project Site. A site off of Cape Fear, a few hundred miles south of the FRF, was considered. At that location, authorized improvements to the Wilmington Harbor Navigation Project were ongoing. Millions of cubic yards of mixed sediments were being dredged from the ocean bar and interior channels. This "real

Figure 1. ERDC's Carl Miller faces the camera on the deck of the M/V Dodge Island as it is placing a load of sediment on the mound.

In this issue . . .

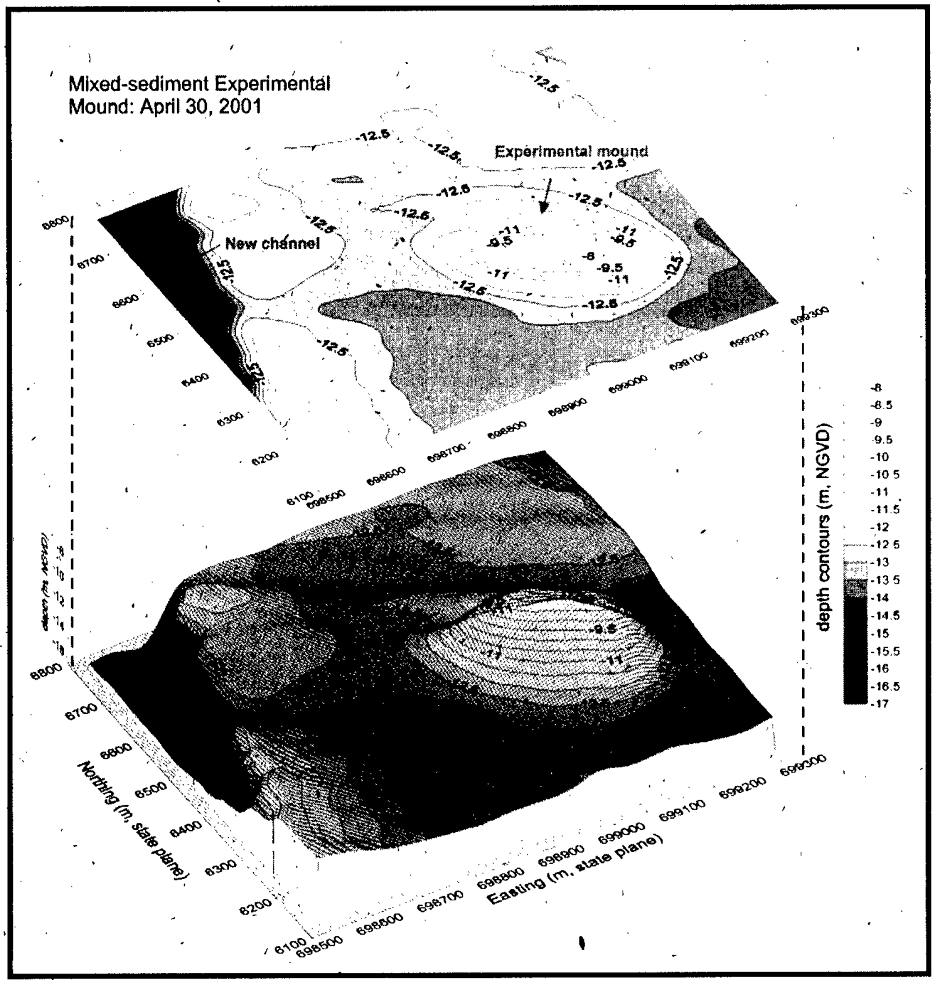


Figure 2. Surveys of the mixed-sediment mound

project" material could be made available for the proposed research. Unlike the FRF site where the study mound location was given and the question was how to get the dredged sediment to that site, the Cape Fear study had an ample supply of dredged sediment but needed an acceptable location for the mound.

Concerns of local shrimpers, beach communities, and environmental agencies precluded a nearshore placement comparable to the FRF site. However, a wide range of acceptable placement options was available in the existing Wilmington Ocean Dredged Material Disposal Site (ODMDS). The Wilmington ODMDS was the planned placement site for much of the sediment anyway, so new environmental clearances were not required. Specific mound location was selected in a corner of the ODMDS, a little more than 3 nautical miles offshore of Baldhead Island and in a water depth of 35 ft.

We approached the Wilmington Harbor Project Manager with the plan. He supported the concepts of the research, but the only way to accomplish the work under the existing dredging contracts was if it did not add cost or time to the ongoing dredging operations. The dredging contractor for the project was Great Lakes Dredge and Dock Company (GLDDC). GLDDC was briefed on the project and asked if they could modify placement operations to facilitate construction of the mound. The dredging contractor said, "No problem." The mound was created without additional cost or time to the Wilmington Harbor project. The GLDDC Hopper Division Team, including the crews of the Motor Vessels (M/V) *Dodge Island* and *Padre Island* were instrumental in the successful creation of the mixed-sediment mound.

Construction. The Cape Fear mixed-sediment mound construction was initiated on Feb. 27, 2001 and finished on March 26, 2001. Adverse currents due to unfavorable weather occasionally kept the dredges from placing sediment on the mound. On those days, the dredges placed sediment in other portions of the ODMDS. The M/V *Dodge Island* placed most of the sediment (Fig. 1). The M/V *Padre Island* also placed sediment on the mound. The crews of the dredges welcomed the scientist on board to take samples of the dredged material and observe the work. Ultimately, 220,000 cubic yards of mixed sediment were placed on the mound. Surveys of the mound (Fig. 2) revealed an elongated mound with a plateau at -16 ft MLLW (Mean Lower Low Water). The shallow plateau provides a nearshore-like condition. That is, if the sediment had actually been placed nearshore, it is not likely that the crest of the mound would have been shallower than -16 ft MLLW because most existing dredging equipment (like that used for the Wilmington Harbor Project) has a limiting draft.

Monitoring Program. We established a monitoring program for the project that is designed to provide information to assess when and how the mound moves, as well as to determine if fine sediment is winnowed from the mound, leaving the coarser sands behind. (See the September 2000 issue of "Dredging Research" (Vol. 3, No. 3) for a discussion of the objectives of the mixed-sediment mound study.) Understanding the sediment separation processes that occur will enhance the beneficial use of USACE dredged sediment. In addition, the concentration and characteristics of the fine-sediment suspended from the mound will be measured. These values will be compared with ambient values to assess whether the levels over the mound are anomalous or consistent with levels throughout Long Bay at the mound of the Cape Fear River.

The monitoring program includes: (1) installation of fixed instruments on the mound to measure sediment transport processes; (2) directional-wave spectra and vertical-current profile measurements inshore, offshore, and on the mound; and (3) repetitive high-resolution bathymetric and sub-bottom surveys. On June 28-29, the first of the instrumentation was installed. Two of the installations consisted of RD Instruments Workhorse Acoustic Doppler Current Profilers (ADCPs). One was located on the mound crest and the other 2 km seaward. In addition to directional wave information and vertical-current profiles, we are using these instruments to measure vertical profiles of turbidity and sediment concentration. This activity brings the number of ADCP sites in the area up to six, extending from the river mouth to 17 km from shore. Near the ADCP on the west end of the mound crest, an array of sensors has been installed to measure sediment transport processes. Included is a down-looking SonTek Acoustic Doppler Velocity (ADV) sensor to measure currents near the crest of the mound and co-located Optical Backscatter Sensor (OBS) concentration instruments. These OBSs measure sediment and turbidity levels in suspension from near the mound crest to 2 m above the crest. In addition, a Sequoia Scientific Laser In-situ Sediment Size Transmissometer (LISST) has been installed to continuously measure the mean sediment size. A duplicate array of instruments was installed on the east end of the mound crest in July. Future monitoring activities include bathymetric and sub-bottom surveys and instrument data collection and analysis; and creation of an FRF Website for rapid access to the information.

Additional information is available from Jack E. Davis, *Jack.E.Davis@erdc.usace.army.mil* and Phil Payonk, *Philip.M. Payonk@saw02.usace.army.mil.*

ERDC researchers provide guidance on determining exposure-based effects of dredged material in confined disposal facilities using plants and worms

Edited by Allison McDonald Brewer, ERDC-WES, Environmental Laboratory, contract support

The U.S. Army Corps of Engineers manages about 300 million cubic meters of dredged material annually. The traditional placement of 5 to 10 percent of material into Contained Disposal Facilities (CDFs) is rapidly becoming problematic because most CDFs are at, or are approaching, their design capacity.

Background

Contaminants in dredged material in CDFs can move from substrates into the food chain because of their contact with CDF-colonizing or inhabiting plants and animals, and as such can cause unacceptable risks outside the CDF. Therefore, placement of dredged material in CDFs and its removal for beneficial use requires assessment of environmental risk. T o this end, the Decision Making Framework (DMF) and the Corps/ EPA Technical Framework may require exposure and effects assessment of relevant contaminant pathways prior to dredging. Such assessment would evaluate impacts on plants and animals in cases where terrestrial placement is selected as a disposal alternative and there is reason to believe that the dredged material is unacceptably contaminated. Currently, no specific guidelines for contaminant residues in plants and animals exist. Moreover, risk assessment based on index species may not give an accurate indication of the fate and effects of the contaminants because the index species may have little relevance to those species inhabiting CDFs or species found where the dredged material can be put to a beneficial use. Thus, standardized and dependable assessments pertaining to relevant biota are needed for credible risk management.

Researchers and scientists at the Engineer Research and Development Center (ERDC), Vicksburg, Mississippi, set out to provide guidance on how to determine exposure-based effects on index and other species, and how to relate this to the fates of contaminants in food chains. To accomplish this, the toxicity of dredged material from CDFs and the bioaccumulation of contaminants from this material were determined in test species. The plants *Cyperus esculentus* (yellow nutsedge) and *Cynodon dactylon* (common bermudagrass), and the invertebrates *Eisenia fetida* (earthworm) and *Enchytraeus crypticus* (enchytraeid worm) were used as test organisms.

Initial survey of CDFs

U.S. Army Corps of Engineers Districts were surveyed to obtain information on upland CDFs within

Dredged material for the plant and animal tests was collected in cooperation with the Detroit District at Monroe, MI, in June 2000. First a bobcat was used to transport the DM-filled buckets, but because of the low-texture of the DM close to the edge of the ponded area most transport had to be done by the project-participants

the U.S. Information was collected on the sediment before dredging, such as contaminant types and levels, bioassays of dredged materials, and freshwater or marine origin. Also, information on chemical behavior of contaminants, survey of biota, bioassays of dredged materials, availability of dredged material for bench- and field-scale testing, and easy accessibility of the CDF was collected after placement into the CDF.

This initial survey focused on freshwater dredged material. The goal was to identify one site to serve as an example for testing of inorganics, and another site to serve as an example for testing of organics. Based on the information collected, three sites in the Great Lakes Area with known pre-dredging contaminant types and levels were initially selected for verification of chemical composition, evaluation of nutrient levels, and preliminary survey of biota. These sites were: Monroe, MI, Manitowoc, WI, and Bayport, WI.

At each CDF, three dredged material samples were collected from the soil surface to approximately 0.3 m depth; one in the wettest area, one in an intermediate area, and one in the driest area. This sampling strategy was chosen based on the assumption that after entering the CDF, the fine-grained particles in the dredged material are transported towards the point of outflow carrying most contaminants, and the sandy particles settle close to the point of entry.

No environmental quality benchmarks for dredged material placed in CDFs currently exist. Recent data collected for EPA's hazardous waste identification rule suggest protective levels for receptor taxa of concern, including terrestrial plants and soil biota. Dredged materials in CDFs can be considered as special cases of terrestrial soils, and therefore, the concentrations listed as protective for terrestrial soil-based communities are likely to be similar to those for CDF dredged materials. Protective levels for terrestrial soils, called "Chemical Stressor Concentration Levels" (CSCL), vary with the receptor taxa. By comparing the recent chemical data with the published CSCLs for terrestrial plants and invertebrates, it was concluded that dredged material of the Monroe CDF would be the most suitable substrate to test for effects of metals since only a few CSCLs for metals were exceeded and none for organics. It was concluded also that none of the dredged material evaluated would be particularly suitable to test for effects of organic contaminants since the only published CSCL for organics, i.e. for PCP, was not exceeded for our test organisms, and several CSCLs for metals were exceeded.

The Monroe CDF was composed of a large ponded area on the discharge side transitioning upwards into mud flats, wetland, and upland areas. The upland area was occupied largely by trees, predominated by willow and cottonwood. This CDF was inhabited by relatively few invertebrates with small population sizes. Soft-bodied invertebrates, such as gastropods and annelids, were absent. Most of the groups identified were insects foraging on the surface (beetles, flies - including larvae, beetle larvae, spiders) and living in the dredged material (collembola or springtails). Progressing upland to drier sites, the taxa remained the same, but numbers of individuals per sample decreased.

The Manitowoc CDF was, like the Monroe CDF, composed of a large ponded area, transitioning into a mud flat, wetland, and upland areas. The vegetated portions of the site included, from lower to higher elevation, low rosette-forming crucifers, *Phragmites australis* (common reed) in the second or third year growth stage, and various *Urtica* species (nettles). At the wet site, a large and diverse Collembola (springtail) population occurred, but few members of other taxa were found at relatively higher diversities at both drier Manitowoc sites. At the driest site, two earthworm species, centipedes, and millipedes were identified. Dredged material sampled at the Manitowoc CDF had remained undisturbed for a long time (several years) relative to that at the Monroe and Bayport Cell 6 sites. Both driest Manitowoc locations, covered with herbaceous vegetation, supported large and diverse invertebrate populations of earthworms, isopods, chilopods, diplopods, and insects. Species composition and population density of the major taxa may be expected to fluctuate from year to year with the vegetation.

The Bayport Cell 6 area contained relatively fresh, unstable dredged material at a uniform elevation, with a groundwater table about 5 cm below the dredged material surface. It was completely vegetated by *Phragmites australis* in 2000, but lacked vegetation in 1999. At this CDF, soil-dwelling invertebrates were very sparse, with only a few surface foraging animals. This may have been because the dredged material was recently placed in the site, the site was wet and unconsolidated, and time was insufficient to allow normal soil processes to develop and provide the microhabitats necessary for colonizing soil invertebrates.

In general, invertebrate density and abundance varied at each site, both being highest at sites where the dredged material had become consolidated, the water table had decreased, and vegetation had been established providing organic matter and microhabitats required for colonization by the animals. The time elapsed since additions of dredged material to the CDFs has been insufficient for the development of a stable vegetation

cover, and the organic material and root structure of the plants has been insufficient for the development of soil depth profiles. As a consequence, the dredged materials in these CDFs are poorly colonized by soil macrofauna and meiofauna. Among the taxa identified, springtails were present at six out of nine sites, and earthworms at one out of nine sites. Based on their relevance for these toxicity tests, springtails and earthworms would be suitable test organisms.

Initial toxicological testing

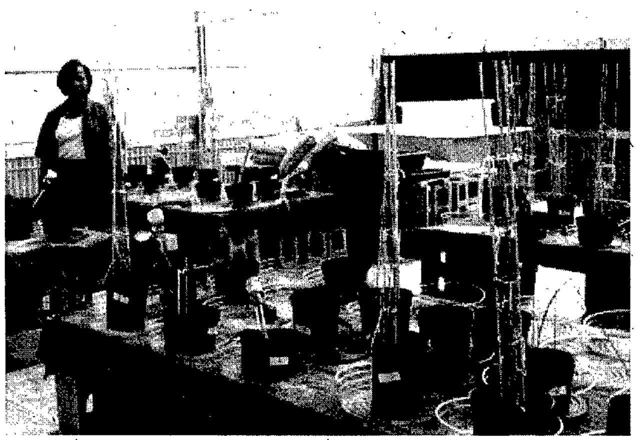
Based on the chemical information on the dredged material of the three CDFs, the Monroe CDF was selected for toxicological testing in the expectation that potential toxic effects could be attributed to the presence of inorganics in the dredged material. As bioassay organisms, common species that might occur at undisturbed sites were used, although they were not identified in the initial survey.

Dredged material was collected at the wettest site of the Monroe CDF. It was transported from Michigan to the Engineer Research and Development Center Environmental Lab (ERDC-EL), Mississippi, in drums. Upon arrival, the dredged material was dried to reduce the moisture content to about 50 percent so the innate microbial community could persist. As a control substrate, two organic soils were chosen, one for plants and one for invertebrates. The test soil and both the control soils were chemically and physically characterized prior to testing.

Plant tests

A multifactorial experimental approach, using a completely randomized design with four replicates per treatment, was used with the following treatments: (1) substrate type, (2) plant species, (3) pot size, and (4) test duration. Two plant species were included, *Cyperus esculentus* (yellow nutsedge) and *Cynodon dactylon* (Bermuda grass). Two pot types with the same 2-L volume were tested, small pots with a 0.0167-m^2 surface area, and large pots with a 0.0238-m^2 surface area. Three test durations were used: for *C. esculentus* 21, 35, and 63 days; and for *C. dactylon* 21, 63, and 77 days.

The experiment was started on July 7, 2000, in a greenhouse on the ERDC-EL grounds in Vicksburg, Mississippi. Pots were placed in saucers, which were replenished daily with demineralized water. Test and control soils were kept at a moisture level of approximately 50 percent. At harvest time, each species was removed from its pot, and plant material was manually freed from soil particles, rinsed with demineralized water, blotted dry, weighed, and dried in a forced-air oven to constant weight.



Plant tests of the dredged material in the ERDC-EL greenhouse. Plant species: Yellow nutsedge and Common bermudagrass. Dr. Linda Winfield participated in the plant tests

Analysis of variance (ANOVA) of the complete dataset indicated that the effect of substrate on growth response (i.e., total biomass) was not statistically significant, but the effects of plant species and test duration were significant. This means that the differences in growth responses of both plant species could not be attributed to differences in substrate type alone. The effect of pot size was also significant, with more below-ground plant biomass of *C. esculentus* being produced in the pots with the smaller surface area, and more total biomass of *C. dactylon* being produced in the pots with the larger surface area.

Plant species also exhibited a different metal specific behavior with respect to bioaccumulation. *C. esculentus* accumulated Pb from 63 days onward in the below-ground biomass (3.31 ± 3.96 mg kg^{-1}); Ni in above- and below-ground biomass in 35 days (5.07 ± 2.38 mg kg^{-1}) and in 63 days (12.2 ± 5.27 mg kg^{-1}); and Zn from 35 days onward (176 ± 7.96 mg kg^{-1} in above-ground biomass and 136 ± 21.3 mg kg^{-1} in below-ground biomass). *C. dactylon* initially accumulated Pb, reaching a level of 1.50 ± 2.99 mg kg^{-1} at 35 days, and subsequently depurating it to an undetectable level. It accumulated Ni from 35 days onward up to 6.89 ± 1.29 mg kg^{-1}; and Zn to 93.6 ± 6.52 mg kg^{-1}. None of the species accumulated V or Hg. Ni and Zn accumulation in plants cultivated on the control soil was substantial compared to plants cultivated on the test soil. The total amount of metals accumulated in plant biomass was usually higher in *C. esculentus* than in *C. dactylon*.

Both plant species may be suitable test organisms for the inorganic COCs in dredged material, in that they survived on dredged material and produced enough biomass to allow evaluation of a growth response and the bioaccumulation of metals. The lack of profound plant toxicity was consistent with the low levels of contaminants in the dredged material. The lower growth response on the test dredged material does not necessarily point in the direction of dredged material toxicity; it may be due partly to a more severe limitation by the low nitrogen supply compared to the control soils. It is recommended that for future testing, test and reference substrate be fertilized with N and P to levels considered sufficient to support growth of the test species.

Invertebrate tests

Three separate experiments were conducted; two using the lumbricid compost worm *Eisenia fetida* and one

Worm tests of the dredged material in an ERDC-EL growth chamber. Worm species: Compost worm. Dr. Henry Tatem participated in the worm tests

using the enchytraeid worm *Enchytraeus crypticus* as a test organism. Experiment 1, a bifactorial experiment using a completely randomized design with four replicates per treatment, was conducted with the following treatments: (1) substrate type, and (2) test duration. Four durations were tested: 12, 28, 42, and 56 days. The experiment was started with 20 adult *E. fetida* specimens per replicate cylinder. Testing occurred at 20 °C under continuous fluorescent illumination. Food, composed of rolled oats and powdered earthworm food, was supplied as needed. Each harvest time, approximately 12 specimens were removed from their cylinders, weighed, and deep-frozen until further processing. Subsequently, the animals were dried in a forced-air oven to constant weight. ANOVA of the complete dataset indicated that the effect of substrate on adult biomass was not statistically significant, but it was significant on reproductive potential. This indicates that reproductive potential is a more sensitive parameter for toxicological effects than adult biomass, and that test results depend on test duration.

Experiment 2 started with 12 juvenile *E. fetida* specimens to explore the youngest possible age at which toxic effects become apparent. It lasted 65 days. Animal biomass and reproductive potential were determined, but bioaccumulation was not measured. The results of this experiment largely confirmed those of experiment 1, but the variability in growth response was lower.

The third experiment was performed to explore culture conditions and culture duration required to harvest sufficient biomass for analysis using a test organism new to ERDC-EL. Plastic petri dishes were filled with a pre-weighed quantity of substrate to be tested, and inoculated with 8-10 *E. crypticus* specimens from a mass culture, using a dissecting needle. Substrates tested were: (1) Monroe CDF dredged material, (2) invertebrate control soil, and (3) standard OECD artificial soil (10 percent finely ground peat moss, 20 percent kaoline clay, and 70 percent silica sand). All petri dishes were moistened regularly with demineralized water, and the animals were fed and incubated at 16 °C for 21 days. All treatments generated live worms at the end of the incubation period. However, counting of individual worms, and separation of worms and substrate, proved extremely time-consuming. It was therefore concluded that prior to further testing, a culture method has to be selected that allows better separation of substrate and test organism.

E. fetida is a suitable test organism for the inorganic COCs in dredged material because the adult specimens survived on the material and produced enough biomass and cocoons in a month to allow the evaluation of a growth response, reproductive potential, and the bioaccumulation of several metals. However, a potential drawback affecting the use of *E. fetida* is that the organism requires the presence of a relatively well-developed plant litter layer for its persistence. *E. crypticus* requires a less organic habitat, and could serve as a test organism for dredged materials with very low organic matter contents. However, at this time, the latter organism cannot yet be used for rapid dredged material toxicity screening.

Summary

Three CDFs in the Great Lakes Area with known pre-dredging contaminant types and levels were initially selected for verification of dredged material chemical composition, evaluation of nutrient levels, and preliminary survey of landscape and biota. All sites were characterized by the presence of a ponded area, an intermediate area occupied by herbaceous vegetation typical for highly disturbed systems, and a forested upland area. Invertebrate diversity and abundance varied at each site, both being highest at sites where the dredged material had become consolidated, the water table had decreased, and vegetation had been established. Springtails and earthworms were fairly common, and are considered as suitable test organisms for these dredged materials. Dredged material of the Monroe site was selected for further bioassay testing of inorganic contaminants. Suitable plant species for testing were found to be *Cyperus esculentus*, yellow nutsedge, and *Cynodon dactylon*, common Bermuda grass. *Eisenia fetida*, an earthworm, was identified as a suitable invertebrate test species, with *Enchytraeus crypticus* as a potential second candidate, the latter particularly suitable for dredged materials with low organic matter contents. The thus generated experience will be used to perform and evaluate exposure-based effects assessments of contaminants in terrestrial plants and animals, and to develop guidance to standardize the interpretation of test results in risk assessment aimed at determining effective long-term management strategies for CDFs.

DOER Project Delivery Team wins USACE PDT of the Year Award

The Dredging Operations and Environmental Research Program's project delivery team has actively pursued a formal program of technology infusion related to dredging and environmental issues. The team, consisting of DOER program management, PIs, and partners, successfully transferred resulting processes, technology, knowledge, tools, and products to the Corps and other stakeholders as well as national and international partners. Products from the Environmental Windows, Risk, Instrumentation, Contaminated Sediments, Nearshore/Aquatic Placement, and Innovative Technologies focus areas reached audiences worldwide. The DOER team developed a plan with clear objectives for technology transfer and application, involving and reaching out to all stakeholders affected by the various research areas. Through synergistic interaction and solutions, and through a unified corporate approach to electronic publishing of all research results on a well-used Web site, the DOER PDT has reached national and international audiences, led by USACE and DoD. As evidenced by the honors, awards, and invitations to participate in projects and events worldwide, this Project Management Business Process (PMBP) approach shows customer satisfaction at a high level.

The DOER PDT received the PDT Excellence Award at the USACE Project Delivery Team Conference 2001, held in Pittsburgh, Pennsylvania. The ERDC was presented with a plaque by the Corps Commander, Lt. Gen. Flowers.

Attending the ceremony were Lt. Gen. Robert Flowers, who presented the DOER PDT plaque and (right to left) Dr. Robert Engler, Mr. Norman Francingues, Dr. Todd Bridges, Dr. Michael Palermo, and Ms. Elke Briuer, APR

Dredging Calendar

2001

October 1-5 - AAPA 2001 Annual Convention, Quebec City, Canada,
POC: *www.aapa-ports.org/conventions.html*

October 10-12 - International Conference on Remediation of Contaminated Sediments; Venice, Italy.
POC: *sedimentscon@battelle.org*

October 11-12 - WEDA and AMIP, III International Congress Ports and Coasts, Challenges of the 21st Century; Vera Cruz, Mexico.
POC: *http://jaws.tamu.edu@oecds/weda.html*

October 22-26 - Convention on the Prevention of Marine Pollution from the Dumping of Water and Other Matter, London convention of 1972, London, UK (for Convention Members only)

November 11-15 - SETAC in North America 22nd Annual Meeting, 2001, Baltimore, MD. Changing Environmental Awareness: Societal Concerns and Scientific Responses. For more information, contact the SETAC Office in North America, 1010 North 12th Avenue, Pensacola, FL 32501-3367 USA (T 850 469 1500; F 850 469 9778; E-mail: *setac@setac.org*).
POC: *http://www.setac.org/balt.html*

2002

January 15-17 - DOER/LEDO/DOTS Program Reviews, Charleston, SC
POC: *skinnerb@wes.army.mil* (Corps only)

February 23-27 - Water Environment Federation, Watershed 2002, Fort Lauderdale, FL.
POC: *www.wef.org*

April 16-19 - PIANC 100th Anniversary Meeting, Vicksburg, MS.
POC: *Maryjane.robertson@usace.army.mil*

May 5-8 - ASCE; Dredging '02, Orlando, FL.
POC: *conf@asce.org*

May 13-16 - WEFTEC Asia Pacific 2002, Kuala Lumpur, Malaysia.
POC: *weftecasiapacific@wef.org*

September 22-26 - PIANC 30th International Navigation Congress, Sydney, Australia

US Army Corps of Engineers®
Engineer Research and Development Center

Articles for *Dredging Research* requested:

Dredging Research **is an information exchange bulletin for publication of ERDC-generated dredging research results. Included are articles about applied research projects. The bulletin serves all audiences and is accessible on the World Wide Web in addition to a paper circulation of 2,800. Articles from non-ERDC authors are solicited for publication, especially if the work described is tied to the use of ERDC-generated research results. Research articles that complement ERDC research or cover wide field applications are also accepted for consideration. Manuscripts should use a nontechnical writing style and should include suggestions for visuals and an author point of contact. Point of contact is Elke Briuer, APR, at *Elke.Briuer@erdc.usace.army.mil.***

Dredging Research

This bulletin is published in accordance with AR 25-30 as an information dissemination function of the Environmental Laboratory of the U.S. Army Engineer Research and Development Center. The publication is part of the technology transfer mission of the Dredging Operations Technical Support (DOTS) Program and includes information about various dredging research areas. Special emphasis will be placed on articles relating to application of research results or technology to specific project needs. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or the approval of the use of such commercial products. Contributions are solicited from all sources and will be considered for publication. Editor is Elke Briuer, APR, *Elke.Briuer@erdc.usace.army.mil.* Mail correspondence to the Environmental Laboratory, ATTN: DOTS, Dredging Research, U.S. Army Engineer Research and Development Center, Waterways Experiment Station (CEERD-EP-D), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call (601) 634-2349. Internet address: *www.wes.army.mil/el/dots/drieb.html.*

James R. Houston

James R. Houston, PhD
Director

OFFICIAL BUSINESS
CEERD-EV-I

DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER
WATERWAYS EXPERIMENT STATION, 3909 HALLS FERRY ROAD
VICKSBURG, MS 39180-6199

PRESORTED STANDARD
U.S. POSTAGE PAID
Vicksburg, MS
Permit No. 85